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Public–private partnerships value in bioenergy projects: Economic feasibility analysis based on two case studies

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ABSTRACT

Greece and Italy are facing serious energy challenges concerning sustainability and greenhouse gas emissions as well as security of supply and the competitiveness of the internal energy market. These challenges require investments by the public sector, while the countries have seen in the last years their debts rising. A solution to promote bioenergy business, without rising public debt, could be the use of PPP (Public–Private Partnership). This paper presents a methodology to develop agro-energy business using PPP in two rural areas: the municipality of Evropos (in Greece) and the municipality of Montefalco (in Italy). At first biomass availability is studied, then the optimal technology is selected. Once technological issues have been analyzed PPP value for money has to be assessed. Conventional methods to evaluate economic viability of a project are not enough and a Public-Sector Comparator (PSC) has to be calculated. Typical risks of bioenergy projects are identified, estimating their probabilities and consequences. This will lead to associate a monetary value to each risk. Then the identified risks are allocated among private and public partners, establishing synergies. The allocation of risks will have consequences on the preparation of PPP contract and on partner selection procedure.

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1. Introduction

1.1. *PPP definition and types of PPPs*

The term PPP (Public–Private Partnership) has its origin in the USA, initially relating to joint public–private funding for educational programs, but came to wider use in the 1960 to refer to public–private joint ventures for urban renewal [1]. After 1978 the Power Purchase Agreement (PPA), developed in USA provided the template of modern PPP contracts and encouraged the construction of cogeneration plants. If we talk about project based or contract based PPPs these can be identified by the following characteristics [1]: a long-term contract between a public-sector party and a private sector party; for the design, construction, financing and operation of public infrastructure by the private sector party; with payments over the life of the PPP contract to the private sector party for the use of the facility; with the facility remaining in public-sector ownership, or

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Nomenclature

CAPEX	Capital Expenditure, €
CF	Cash Flow, €
CP	Conventional Procurement, –
DB	Design Build, –
DBB	Design Bid Build, –
DBFOM	Design Build Finance Operate Maintain, –
IRR	Internal Rate of Return, %
NPC	Net Present Costs, €
NPV	Net Present Value, €
OPEX	Operating Expenditure, €
PSC	Public-Sector Comparator, –
r	Discount rate, %
SB	Shadow Bid, –
SP	Simple payback Years
TPR	Third Party Revenues, €
VOR	Value of Risk, €

reverting to public-sector ownership at the end of the PPP Contract. The most important difference between Conventional Procurement and PPP is that while PPP deals with the integration of two or more phases of the project (for example design, construction, operation, maintenance etc.) into a contract lasting for all the concession period, in conventional public procurement each phase is procured separately. Besides PPP contracts are output-based, payment is done upon delivery, there is private financing and private sector project stewardship; while conventional public procurement contracts are input-based, there are monthly payments, private financing is limited and project stewardship is under public responsibility [2]. In Conventional Procurement (CP or DBB) even the construction phase is considered under public body responsibility. PPPs can be classified, based on private partner involvement. In the case of DBFO, for example, the risks of construction and ownership belong to the private sector, that on the other hand receives the payment of a toll (for example) from the users of the facility or service that has been built. In DBFO the property of the facility can be public or private. In DB (Design Build) the private partner designs and builds the facility that will be operated by the public. At the moment few studies deal with the application of PPPs to the renewable energy sector, one of the most important is that of Martins et al. [3], in which we find a case study on a wind power plant tender. In that analysis important issues are taken into account, like: private partner selection (through bids analysis), contract structure, risk sharing and contract management. Public-Sector Comparator is not taken into account, but it is important as a value for money calculation method in PPP projects [4], especially if they deal with bioenergy projects. This kind of projects has an important difference, respect to wind power projects: there are often two useful products, power and heat, instead of only one (power). In this case, while electricity could be sold on the national grid by the private or the public partner or by a shared public–private society (for example an S.P.V.), it is desirable that the heat produced will be used in public heat sinks (such as sport facilities, education service offices, hospitals etc.). So the public body can reduce the expenses linked with space heating, while the private partner will receive an income for the service performed. Once the convenience of PPP contracts has been proven, they can be the solution to the credit availability problem of public bodies in Spain, Greece, Portugal, but also in Italy. Greece and Italy don't have at the moment a formal methodology for PPPs value for money analysis.

Table 1 – Number of PPPs projects in Italy and Greece.

Sector	Italy (UTFP 2002–2012)	Greece (Special PPP Secretariat 2002–2012)
Water, Energy and Telecommunication	3303	0
Tourism	987	1
Urban green, urban qualification, hygiene, monuments	3722	4
Multipurpose centers	88	1
Cemeteries	757	0
Commerce and artisanship	1684	0
Directional & Administrative	31	25
Sport infrastructures, Parks, Free time	4659	3
Health	460	4
Education and social	495	1
Transport	195	1
Others	397	3

To know some statistics on PPP contracts implemented in Greece and in Italy data can be collected from the two national agencies: UTFP for Italy (UTFP is the Italian Unit of Project Financing, belonging to the Inter-ministerial committee for prices -CIPE-) and the Special Secretariat for Public–Private Partnerships of the Ministry of Economy and Finance, for Greece. A summary of the main PPP projects in Greece and Italy updated to 2012 is proposed on Table 1 [5,6].

From Table 1 we can see that Greece has no PPPs in the energy sector, while Italy has an interesting number, but few of them regard bioenergy projects. At the moment there aren't reliable statistics on the approved PPPs, dealing with bioenergy projects, in Italy and Greece. The number of PPPs realized in Italy is very big, compared to that realized in Greece, but this can be explained with the fact that the budget of the average Greek PPP (equal to 95 M€) is greater respect to that of the average Italian PPP (equal to 4 M€). For these reasons, the paper finds its originality in the design of an effective methodology for a successful use of PPP schemes to promote agro-energy business in two case studies.

1.2. *Bioenergy projects and PPPs*

During the development of a project, especially dealing with bioenergy, different risk typologies can be faced: plant reliability, plant economics and contracts and warranties [7]. The risks faced in a bioenergy project can be controlled comparing plant performances, improving training and maintenance services, analyzing correctly plant economics and plant guarantees. Besides an important advantage of PPPs is represented by the fact that plant reliability risk and in general technology risk can be allocated or transferred to the private partner, selecting and fixing the required warranties in the contract. Risks and or sustainability issues in bioenergy chains are presented by Refs. [8–10]. In Mangoyana and Smith [9] case studies of decentralized bioenergy projects are classified, depending on whether they are based on: community initiative, public–private initiative, public initiative and private initiative. In Table 2 a summary of the possible risks for each typology of project is provided and it is also shown how Public–Private Partnerships can be used as a possible risk reduction tool, allocating risks among private and public partners. The risks presented in Table 2 can be classified as: environmental, economic, social, but also technical. The first three categories of risks can be considered as non-technical. Besides we see from the technology road maps of the European Industrial Initiative on bioenergy that the increase of knowledge on thermo-chemical pathways has to be reached within 2015 as an industrial sector objective. Knowledge on combustion reactions of biomass and process optimization has reached a good level of deepening [11]; research on pyrolysis process has cleared several aspects, as it can be seen from Ref. [12]. Gasification technologies are always more reliable [13]. Methods for the reduction of pyrolysis/gasification tar in producer gas are continuously improving [14]. Research on torrefaction [15] has brought interesting results and also biomass assessment [16] and logistics [17] have achieved a good level of development. Further linkage of technical development to market/community needs and protection of private investors from bioenergy risks could be efficiently done through the use of Public–Private Partnerships. This is possible because risk transfer is the heart of the structure of a PPP project.

Cost reduction in a PPP project can be done both: through synergies (between partners), but also reducing project authorization costs. In fact project authorization costs are an important part of investment costs. As it is shown in Ref. [18], permitting costs in a bioenergy project vary from 0.1% of the investment for boilers, to 7% of the investment for biogas.

2. Methodology and data

2.1. *Application of Public–Private Partnerships to bioenergy projects*

For what has been above said it can be understood that the process of implementing a PPP, within an agro-energy business, depends strongly from country legislation. In Greece PPPs are based on the Law 3389/2005, mainly referred to concessions schemes. In Italy, at the moment, there are 7 forms of PPPs and they can be classified in two main typologies: Contractual and Institutional. The Contractual PPP is based on a concession contract to build and operate. The concession contract could be based on an agreement born by a private initiative or a public initiative. The Institutional PPP is based on a Special Purpose Vehicle (SPV), which shares are both private and public. Despite the differences existing among the Italian and Greek legislations, a common methodology for the implementation of PPP contracts for bioenergy projects is proposed in this paper, see Table 3.

Table 2 – Bioenergy project risks and their possible allocation through PPPs.

Risks	Possible allocation	
	Private	Public
Limited business management and technical skills	X	
Unreliable biomass supply	X	X
Lack of capital to invest	X	
Market is not ready for bioenergy		X
Lack of public acceptability		X
Pooling various types of resources together	X	X
Competition is unfair for small privates		X
Complicated authorization procedure		X
Costs of biomass	X	X
Taxes, fees, guarantees		X

The analysis of the area (that is biomass availability assessment and bioenergy monitoring) has already been explained in Refs. [8,19]. Also stakeholders involvement has been already discussed. The main results of phase 1 for the Italian case study are proposed in Fig. 1, in which we see the availability of solid biomasses for the municipalities belonging to Umbria region. In the map it is indicated Montefalco municipality, that is the one in which the methodology is applied. The Greek case study is applied to the municipality of Evropos, situated in the region of Toumpa Kilkis.

2.2. *Economic feasibility analysis*

Once data on biomass availability of the target areas have been collected and elaborated to estimate potential producible power and heat, the choice of the most suitable technology to employ is done through a SWOT analysis in which Strengths,

Table 3 – Methodology for the implementation of PPP contracts for bioenergy projects.

Phase	Step
1) Study of the area	Data collection Biomass production estimation Calculation of heat power available Calculation of electricity power available
2) Project selection through SWOT analysis	SWOT analysis and project identification
3) Stakeholders involvement	Identification criteria
4) PPP value for money	Investment analysis PSC Calculation - RAW PSC calculation - Construction of the risk matrix - Identification of the specific risks - Quantification/calculation of the consequences of risks - Estimation of the probability of risks - Valuation of the costs of risks - Allocation of the risks
5) PPP contract development	PPP scheme definition Individuation of evaluation criteria Design of the PPP contract
6) Tender	Tender publication and pre-qualification Invitation to present bid
7) PPP management	Managing responsibilities Monitoring Contract modifications

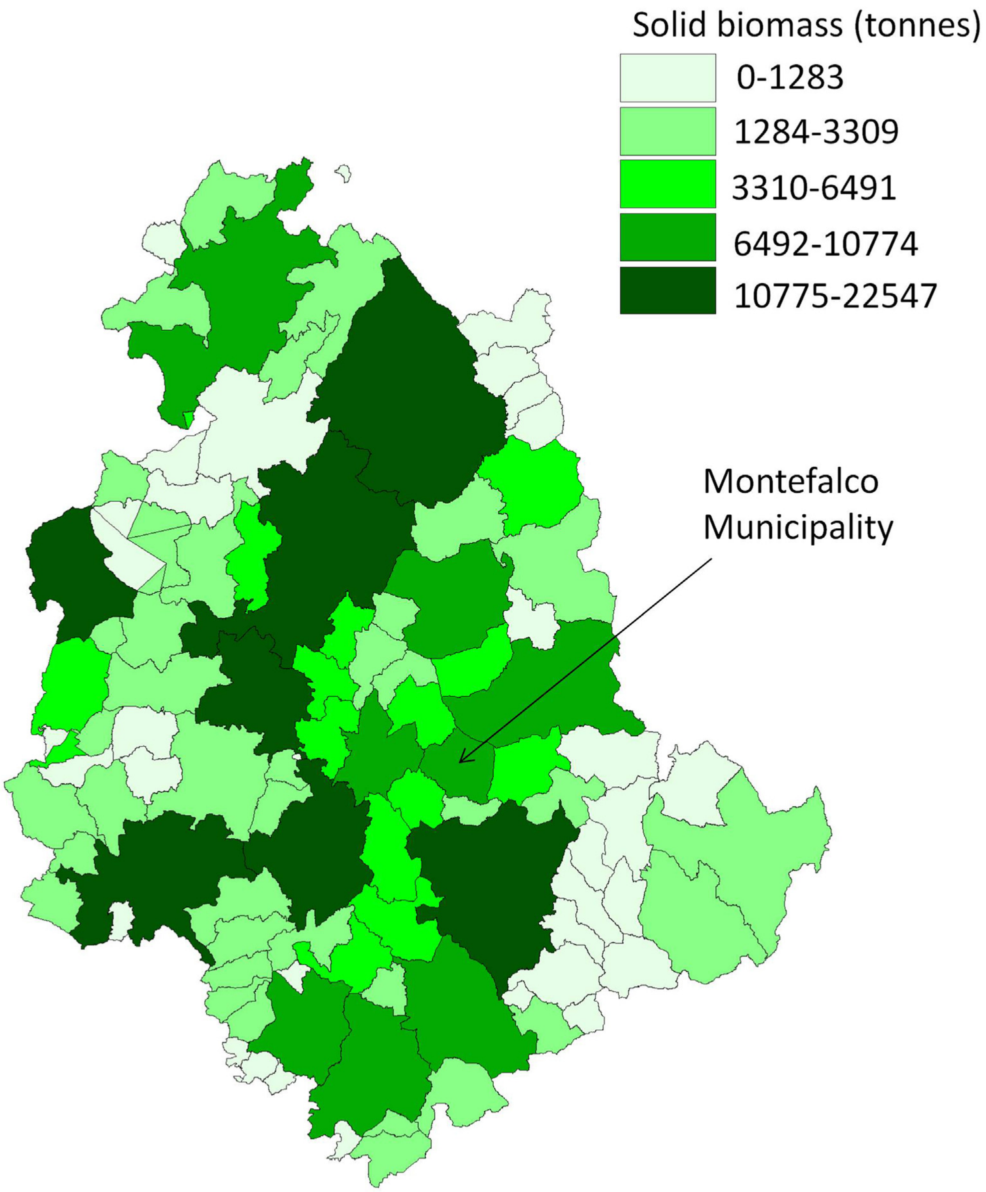

Fig. 1 – Solid biomass production in each municipality belonging to Umbria region (Italy).

Weaknesses, Opportunity and Threats of the target area are discussed. Then the chosen technology economical convenience respect to competing technologies on the market, can be assessed with a conventional investment analysis, that has been performed using the Software RetScreen, developed by the Canadian Minister of Natural Resources. This software is specific for the evaluation of economical convenience of renewable energy systems and energy efficiency measures.

Conventional investment analysis gives not a final judgment on the feasibility of the bioenergy project in case we want to perform a PPP. In this case CAPEX and OPEX will be allocated between private and public partner as well as risks. So the convenience of the project depends exclusively on the way risks are transferred to the private partner and on the cash flow of variable and fixed costs sustained by the public partner. If the cost sustained by the public partner, to deliver a project/service alone, is higher than the cost corresponding to the public partner once the project/service is delivered together with one or more private partners, then the PPP is convenient. We have at first to model the costs (and in some cases the revenues) associated with a project delivered by the public partner alone (this is called Public-Sector Comparator) and then to compare it with the costs sustained by the public partner in a PPP project.

3. Public-sector comparator calculation

In this paper the methodology followed to calculate PSC is composed by these steps: calculation of the Raw PSC, construction of the risk matrix; identification of the specific risks; quantification/calculation of the consequences of risks; estimation of the probability of risks; valuation of the costs of risks; allocation of risks [20]. Raw PSC represents the cost for the public partner to deliver the reference project before taking into account adjustments for competitive neutrality and risk. Raw PSC can be calculated with equation (1) [21]

$$\text{Raw PSC} = (C_{O\&M} - \text{TPR}) + \text{CAPEX} \quad (1)$$

where $C_{O\&M}$ and CAPEX represent respectively net present operation and maintenance costs and net present capital costs. An important issue in bioenergy projects results to be TPR (Third Party Revenues). These can be derived, as reported in Ref. [22], from sales of terrain, rental or advertising. All the costs and revenues should be on the entire life cycle of the project and converted in Net Present Values (NPV). Then the raw PSC will be adapted adding the value of risk, see formula (2), that can be used both for retained and for transferred risks.

$$\text{VOR} = \text{consequence} * \text{probability} \quad (2)$$

Final PSC value will be calculated following equation (3).

$$\text{PSC} = \text{Raw PSC} + \text{Competitive neutrality} + \text{Transferred risk} + \text{Retained risk} \quad (3)$$

Once PPP value for money has been analyzed, the most convenient PPP will be identified comparing PSC with a Shadow Bid (see Fig. 2).

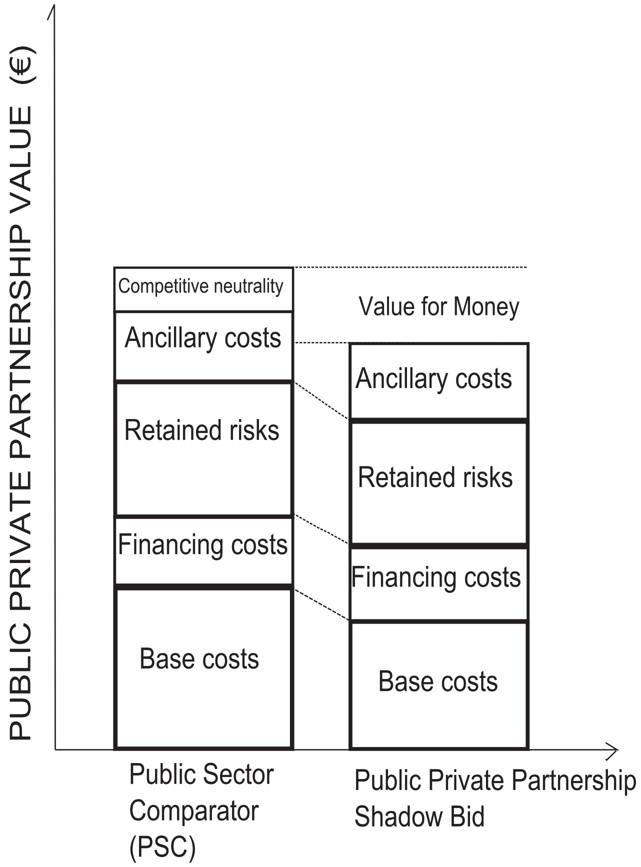

Fig. 2 – Generating value for money through efficiencies.

4. Results

4.1. *Technology selection through SWOT analysis*

As before mentioned the Italian PPP case study sees as public partner Montefalco Municipality, situated in Umbria region (central Italy). The municipality has a large availability of vineyard pruning residuals. The entrepreneurial network can allow the organization of an efficient raw material supply chain, considering land characteristics. Vineyards in the target area have a surface of about 600 ha and produce about 2 ton/ha of prunings. These could be used to produce heat in a biomass boiler. Agro-energy chain deals with the realization of a plant for energy recovery from vineyards pruning residues and it is divided into different phases, that is: harvesting and storage by round baler, chipping cylindrical bales to obtain bio-chips, storage and energy conversion phase. The estimated feasible capacity of the plant would be 0.4 MWth moving grate fed with wood chips. This capacity could be used to provide heat to big energy sinks, as hospitals or schools or sport centers.

The Greek case study sees the Municipality of Evropos as the public partner. Evropos is situated in the Toumpa-Kilkis region (northern Greece). The Tobacco Cooperative of Toumpa-Kilkis (TCTK) plans to realize a plant in the municipality in order to produce pomegranate juice. The PPP project considers the use of biomass residues from this plant (such as seeds and peels), as well as the use of biomass residues from the adjacent cultivated areas for the production of energy. The produced energy can be used for the following purposes: to provide heat to public buildings in the Municipality, to sell electricity to the National Public Power Corporation as energy from RES. The chosen technology, for the Greek case, is an Organic Rankine Cycle of the power of 1 MWe. We see from Table 4 how the choice of the technology has been guided by SWOT analysis.

4.2. *PPP value for money*

4.2.1. *Conventional investment analysis*

As it has been said before, in the Materials and Methods section, investment analysis has been used, to identify the most convenient technology. Total estimated investment cost (CAPEX) for the bioenergy project in Italy and Greece is respectively 314,000€ and 4,810,00€; while OPEX are respectively 36,041€/year and 778,453€/year. For the Greek case study it is expected that compensations will be paid to farmers in the target area, who are using at the moment their biomass for other purposes. The need for compensations will be smaller for farmers that currently don't have an alternative way for utilizing their biomass (e.g. prunings), but need to dispose it using other means. An average compensation price for biomass has been estimated at 40€/ton. A fixed price of 0.082€/KWhe and 0.04€kWht and a production of 7712 MWh electricity per year and of 25,625 MWh thermal have been considered. The objective of the Italian case study is to produce heat from vineyard prunings collection. Investment costs are represented by: the costs necessary to buy a round baler to collect prunings, the costs of plant design and realization and the costs of buildings. The cost of biomass collection is estimated at about 70€/t d.m. The price of the heat sold to the Municipality is about 70€/MWh. The results of the financial analysis are shown in Table 5.

We see from Table 5 that both projects have positive NPVs, while the payback of the Italian project is higher respect to the Greek one. This can be explained with the costs of biomass

Table 4 – SWOT analysis for Montefalco municipality (above) and for Evropos Municipality (below).

Italy (Montefalco municipality)	
Strengths	Weaknesses
The municipality has small population	The vineyards are not owned by a single person
The cultivation is specialized in two very important productions: grape-vine and olive tree	Population is not so much involved
Agricultural activities are very important in the area	Biomass use for energy purposes in many aspects bring controversies and doubts
There is good availability of agricultural residues	
There is already in the Umbria region a plant working with vineyard pruning residues	
The municipality has already available an artigianal area to use to host the bioenergy plants	
Very few biomass is used at the moment in the target area	
Opportunities	Threats
To produce heat and electricity from biomass will grant energy autonomy to some energy sinks in the target area	Big plants need huge investments and big effort during authorization
Bioenergy sector will create employment in the area	Huge plants need also big quantities of biomass
Agricultural operators will have incomes coming from new activities	In the case of biogas the disposal of the residual of anaerobic digestion could be a problem
There is more need of heat than electricity	Biomass CHP technology on small scale are not so diffused
Greece (Evropos Municipality)	
Strengths	Weaknesses
High biomass availability from agricultural residues;	The agricultural land is divided in many small parts, e.g. many land owners
Easy to collect residues from the fields	
Opportunities	Threats
The deregulation of the energy market of Greece facilitates the selling of electricity produced by an agro-energy plant to the Public Power Corporation;	Bureaucracy of small-scale PPP approval
The connection to the PPC network is very easy	
Biomass CHP plants have been already studied in Literature	

that in the first case has to be collected with high costs, while in the second case the most part it is available as a residue of agroindustrial activities.

4.2.2. *Risk analysis*

Bioenergy project risks have been identified and are proposed in Table 6. Table 6 is divided in four parts: risk classification, risk value – Italy, risk value – Greece, risk allocation. Risk typologies have been grouped in 6 categories: Fuel Supply, CAPEX, O&M, Electricity Export rate, Finance and Others. The probability and consequence of different risks in Italy and Greece are estimated based on the report "Risk quantification and Risk management in Renewable Energy Projects" prepared by Ref. [23] and on the experience gained on real plants. The calculation of risk probability and consequence belongs to the quantitative risk analysis. First we will take into consideration the probability of risk, that is linked with risk frequency or likelihood of occurrence. In this case, if available, this analysis could be based on historic data from other projects from which a probability distribution of the selected risks can be traced. Once probability of different risks has been assessed, it has to be found the element of the project that is affected by this risk (for example: costs, revenues or schedule). In our case risk consequences are linked with the following elements: fuel cost, CAPEX, O&M costs, income from sold electricity and heat. Each time a risk actually occurs it will determine a quantifiable consequence, that will have a probability distribution. We will have lower probability if protection and prevention measures have been undertaken. Risk consequence could be calculated using parameters (for example if we know that the risk of bioenergy plant damage implies an expenditure that is dependent on spare parts and manual labor, we can estimate this increasing expenditure and calculate the percentage increase of annual O&M costs). On the other hand risk consequence can be estimated also using experience of the operators of the sector, for example if we know that in our experience a sudden rescission of the biomass supply contract will cause a percentage increase in yearly fuel expenditure we can apply this factor (that is the consequence of the risk) to fuel costs. Multiplying the two terms of risk probability and consequences we obtain the value of risk, that is referred to one year. This process is repeated for each year of project life cycle and each value is discounted. A risk typology is assigned to private or public partner, depending on the type of contract (CP, DB and DBFOM). In the case of Conventional Procurement only construction risk in under the responsibility of the private partner. In the case of Design and Built the private partner is

Table 5 – Financial indicators.

Financial indicators	Unit	Italy (0.4 MWth moving grate)	Greece (1 MWe ORC cycle)
		Value	
IRR	%	12.9	14.8
Simple payback	Yr	6.2	5.5
Equity payback	Yr	6.4	5.8
Net Present Value (NPV)	€	181,274	4,011,334
Annual life cycle savings	€/yr	17,464	321,880
Benefit-Cost (B–C) ratio	–	1.58	1.83
GHG reduction cost	€/tCO_2	69	275

Table 6 – Valuing risk.

Risk classification		Risk value – Italy			RISK value – Greece			RISK allocation		
Category	Risk typology	Probability (%)	Consequence (%)	Risk value (€)	Probability (%)	Consequence	Risk value (€)	CP or DBB[a]	DB[b]	DBFOM[c]
1) Fuel Supply	1.1) Biomass availability/contract	15	30% fuel cost	834	2	10% fuel cost	19,235	Pub.[d]	Pub.	Priv.[e]
	1.2) Biomass price	10	20% fuel cost	371	15	21% fuel cost	8549	Pub.	Pub.	Priv.
	1.3) Logistics implementation	10	25% fuel cost	464	10	15% fuel cost	10,686	Pub.	Priv.	Priv.
2) CAPEX	2.1) Technology choice and plant design	10	30% CAPEX	9420	10	25% CAPEX	144,300	Pub.	Priv.	Priv.
	2.2) Project management	10	10%CAPEX	3140	5	10% CAPEX	48,100	Pub.	Pub.	Pub.
	2.3) Land acquisition	20	3%CAPEX	1884	5	3% CAPEX	28,860	Pub.	Pub.	Pub.
	2.4) Construction	3	20%CAPEX	1884	10	10% CAPEX	28,860	Priv.	Priv.	Priv.
	2.5) Grid connection	3	5%CAPEX	471	15	15% CAPEX	7215	Pub.	Priv.	Priv.
3) O&M	3.1) Operation and maintenance	10	25%O&M	363	10	25%O&M	5000	Pub.	Pub.	Priv.
	3.2) Performance	15	20%O&M	435	4	20%O&M	6000	Pub.	Pub.	Priv.
4) Electricity export rate	4.1) Price of electricity (opportunity cost)	0	0%	2442	10	20% Income from electricity/heat	49,669	Pub.	Pub.	Priv.[f]
5) Finance	5.1) Debt term	15	5% CAPEX	5372	5	5% CAPEX	124,662	Pub.	Pub.	Priv.
6) Others	6.1) Environment	10	15%CAPEX	4710	30	15% CAPEX	72,150	Pub.	Pub.	Pub.
	6.2) Authorization legal aspects, public acceptance	10	3%CAPEX	942	5	15% CAPEX	14,430	Pub.	Sha.[f]	Pub.

[a] CP or DBB stands for Conventional Procurement or Design Bid Build.

[b] DB stands for Design Build.

[c] DBFOM stands for Design Build Finance Operate Maintain.

[d] Pub. stands for Public.

[e] Priv. stands for Private.

[f] Sha. stands for shared 50% Public 50% Private.

responsible of logistics, technology choice, construction and grid connection costs and risks. DBFOM PPP represents a different situation, because in this case management and operation of the plant (and also financing step, as previously said) are charged to the private partner, so we assume it will be rewarded with the tariffs derived from the sale of electricity, while the heat will be used by the Municipality (in the case of Montefalco) in public buildings and for this reason the public partner will pay a tariff to the private. In the Greek DBFO we have supposed the public will contribute to investment costs paying for the district heating part of the plant and so having as a counterpart free heat generated by the CHP ORC plant.

4.2.3. *PPP value for money: PSC (Public-Sector Comparator) versus Shadow Bid (SB)*

Raw PSC has been calculated based on project cash flow, considering: discounted capital costs, discounted O&M costs and revenues. These are represented by the sale of electricity (inserted as a third party revenue, in the Greek case). Once Raw PSC has been calculated, we have to consider competitive neutrality and value of risk. Competitive neutrality stands for the net competitive advantages that accrue to a government business due to its public-sector ownership and it is calculated based on data presented in Ref. [18]. In this work the value of risk has been calculated based on the valuing risk matrix reported in Table 6, assuming that risks happen more times during project duration.

PSC is calculated with formula (3). Once the PSC value is available, it has to be compared with the Shadow Bid of the PPP (which represent an estimate of the offer that will be presented by the private partner during the bidding phase). So PPPs discounted cash flow have been calculated taking into account the advantages in cost reduction and risk reduction obtainable with a partnership with private sector. The comparison of PPP Shadow Bid and PSC shows that: the DB solution can produce savings of 12.8 and 12.9% for the Italian case and the Greek case respectively (see Table 7). On the other hand, in the Italian case, the DBFO solution is not convenient, because the public energy sink, paying a tariff that will cost more than realizing the plant. This is obvious because biomass boilers have quite short payback and the income in the long period is high. The DBFO in the Greek case proves to be very convenient, because the municipality transfers all the risks of construction, maintenance and biomass supply on the private partner and invests on a district heating line that produces heat for free. The payback of such a plant, deprived of the heat sale income, will rise to about 10 years (considering that part of the capital costs and O&M costs are covered by the Municipality of Evropos).

The comparison of PSC with a Shadow bid has surely limitations that we have to take into account. For example we are comparing now two cash flows that will be very influenced by the operative conditions that will be encountered in the building phase of the project, that will happen several months (if not years) after the procurement process. Another important limitation it is surely the estimation of competitive neutrality, that is the advantages of the public sector in managing some aspects of the project. As far as we know Greek an Italian public bodies could have some competitive advantages by the point of view of authorizations and administrative procedures but they have also low efficiency in managing time and deadlines. We must focus also on the aspect of risk allocation among private and public subjects because both PSC and Shadow Bid are based on it. Despite this, allocation is not fixed at the moment of the comparison, because it will be in the final PPP contract. So the final decision taken from the comparison of the PSC and Shadow bid is based on risk allocation which should remain constant during the tendering process and should be fixed at last in the PPP contract, using also appropriate guarantees to protect it.

Table 7 – Comparison between the PSC and the Shadow Bids calculated for DB and DBFO PPPs.

Description	Italy	Greece
PSC Calculation		
PSC (€)	920,107	11,975,800
Shadow Bid for design build PPP		
SB PPP-DB (€)	801,129	10,437,300
Savings (%)	12.9	12.8
Shadow Bid for design build finance operate PPP		
SB PPP-DBFO (€)	1,484,241	9,708,098
Savings (%)	No Savings	18.94

4.3. *PPP contract development*

Finally after economic convenience of the project has been assessed the PPP contract will be prepared. An example of contract is proposed in Table 8. The contract is a clear example of concession contract and it is the most used for PPPs, both in Italy and Greece. It is based on a database of PPPs contracts contained in the site of the Italian Observatory on PPPs [24]. We see that it examines fundamental aspect, such as: construction, management and end of contract. Construction requirements and responsibilities are cleared (see art.7–8). The required deadlines and penalties are cleared (art.10) and insurance system is provided (art.11).

Besides also the space for tariffs definition is present (see art.16 and 17), even if in the Italian case study they were not convenient.

5. Discussion

In this paper we have seen how PSC (Public-Sector Comparator) integrates conventional investment analysis enabling the public body to select the best risk allocation strategy. While conventional investment analysis continues to be the right approach to use for private investors, PSC approach is useful for public bodies, governments and agencies that want to invest in bioenergy through a Public–Private Partnership contract. In this study PSC has been used as a further indicator of economical convenience, that is specific for PPPs projects. It is interesting to compare the final value of the NPV obtained with investment analysis (181,274 for the Italian case study and 4,011,334€ for the Greek case study, see Table 5) with the values of the PSC (920,107 for the Italian case study and 11,975,800 for the Greek case study see Table 7). In the case of the NPV (used in conventional investment analysis) the value

Table 8 – PPP contract structure for a biomass to heat project.

Section 1: Object and duration of the concession
Art.1: Object of the concession;
Art.2: Responsible of the procedure and Agreement duration;
Section 2: Construction
Art 3: Project documentation and attachments;
Art.4: Executive project revision and relative authorizations;
Art.5: Area delivery and beginning of the work;
Art.6: Work execution;
Art.7: Work director, responsible of work and security coordinator in execution phase;
Art.8: Responsibility of the project and work;
Art.9: Variations of the project and contingencies;
Art.10: Work completion deadline and delay penalty
Art.11: Insurance system
Art.12: Security plan;
Art.13: Work completion and start of management;
Art.14: Guarantee for faults and defects in the work;
Section 3: Management
Art.15: Object of the management;
Art.16: Incomes from management and tariff;
Art.17: Tariff adjustment;
Art.18: Responsibility of management and periods and time of service
Art.19: Extraordinary maintenance of the plant;
Art.20: Modifies to the plant and maintenance legislation and normative;
Art.21: Heat supply contracts and further dues;
Art.22: Assurance policies;
Art.23: Contract transfer;
Art.24: Management of the rescission clause;
Art.25: Guarantee for the management;
Section 4: Contract termination
Art.26: Economical accounting;
Art.27: Contract decay;
Art.28: Competent tribunal;

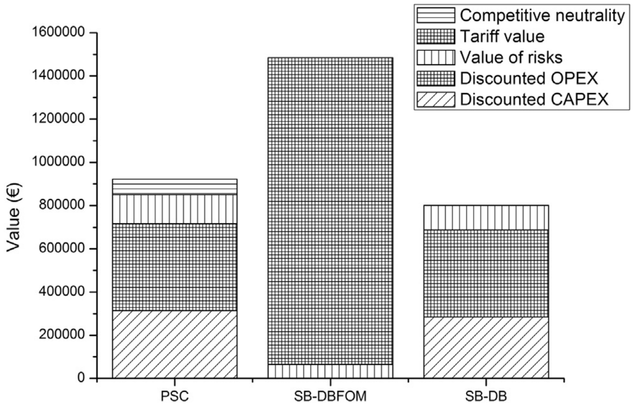

Fig. 3 – Comparison between PSC and Shadow Bids for the Italian case study.

represents the positive cash flow of the whole project which considers the income coming from the spared heat/electricity. In the case of the PSC the heat is consumed by the public partner but it is not linked with a revenue or with a cash flow, for this reason the value of the Raw PSC is represented only by the costs necessary to provide this service (eventually subtracted of the revenues deriving from electricity sale, for the Greek case). Both the NPV and the Raw PSC refer to the entire project life cycle (15 year for the Italian case study and 20 years for the Greek case study). We see from the performed analysis how PSC convenience depends by the type of PPP chosen and by specific situation. Not always DBFO are the most convenient solution. In some cases to fix an energy tariff for 20 years can be not convenient. On the other hand bioenergy plants have important capital and O&M cost that should be accurately financed. Besides we have also to underline the fact that in this study the savings obtained with DB are maximally around 13% of the PSC value. We would expect an average saving of the PPP if compared with the PSC around 17% (see Ref. [4]) but this term is strongly influenced by the way monetary risk has been calculated.

The detailed comparison among PSC and Shadow Bids is proposed in Fig. 3 for Italy and Fig. 4 for Greece. From Fig. 3 we see once again as the tariff necessary to buy heat from the private subject that manages the biomass boiler is very high, if compared with the solution in which the public partner realizes and manages the plant (PSC). From Fig. 4 we see that revenues are subtracted to discounted OPEX and CAPEX and they are represented by electricity sale that is not used by the municipality but sold on the grid, so it can be considered as a third party revenue.

6. Conclusions and policy implication

The paper is based on the work made during the project ‘RuralE (Public–Private Partnerships for RES Agro-energy districts)’ of the European programme Intelligent Energy and presents the Public–Private Partnerships (PPPs) for agro-energy districts. The University of Perugia and Thessaloniki were partners and decided to implement the results obtained improving economic calculation of value for money of the PPP project. This is a new topic and there are no work published on bioenergy PPPs value for money. The methodology implemented is based on the Public-Sector Comparator calculation. This can be defined as a model of the costs of a proposal under government delivery or “a theoretical calculation of the total costs for the public sector of developing and operating an infrastructure and/or

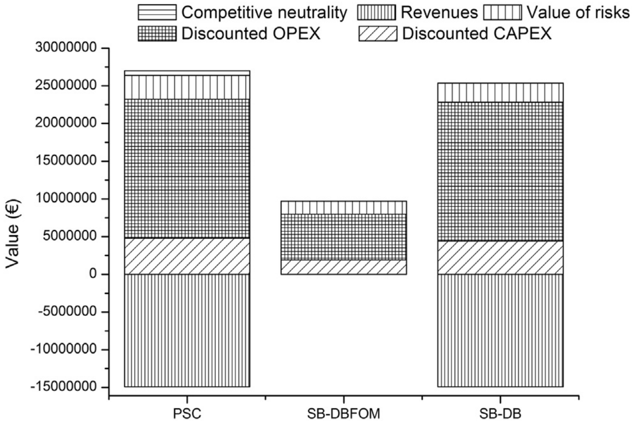

Fig. 4 – Comparison between PSC and Shadow Bids for the Greek case study.

service" [22]. To calculate the PSC four steps were followed: construction of the risk matrix; identification of the specific risks; quantification/calculation of the consequences of risks; estimation of the probability of risks; valuation of the costs of risks; allocation of the risks. This methodology was applied to a municipality in Northern Greece and a municipality in central Italy. In the first a project to provide electricity and heat through the realization of 1 MWe plant based on an ORC cycle was analyzed; in the second a boiler fed with vineyards prunings to provide heat to a public sink was analyzed. The results show that the convenience of different typologies of PPPS (such as DBB, DB and DBFOM) is influenced by risk allocation. With a DB, the savings are of 12.9% for the Italian case and 12.8% for the Greek case. With a DBFOM based on tariffs there are no savings for the Italian case study; with a DBFOM based on CHP heat exploitation in the Greek case savings of about 19% are reached. We conclude that PPPs can be an effective tool to reduce risk in bioenergy business for the public sector. This advantage together with the reduction of the accounted costs, due to the particular accounting rules of the PPP make them useful for bioenergy projects. Besides PSC (Public-Sector Comparator) could be a useful tool to evaluate PPPs convenience by the point of view of the public partner, so it could integrate conventional investment analysis. On the other hand the comparison of PSC with a Shadow bid has surely limitations that we have to take into account. For example we are comparing now two cash flows that will be very influenced by the operative conditions that will be encountered in the building phase of the project, that will happen several months (if not years) after the procurement process. Another important limitation it is surely the estimation of competitive neutrality, that is the advantages of the public sector in managing some aspects of the project. As far as we know Greek an Italian public bodies could have some competitive advantages by the point of view of authorizations and administrative procedures but they have also low efficiency in managing time and deadlines. We must focus also on the aspect of risk allocation among private and public subjects because both PSC and Shadow Bid are based on it. Despite this, allocation is not fixed at the moment of the comparison, because it will be in the final PPP contract. So the final decision taken from the comparison of the PSC and Shadow bid is based on risk allocation which should remain constant during the tendering process and should be fixed at last in the PPP contract, using also appropriate guarantees to protect it.

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